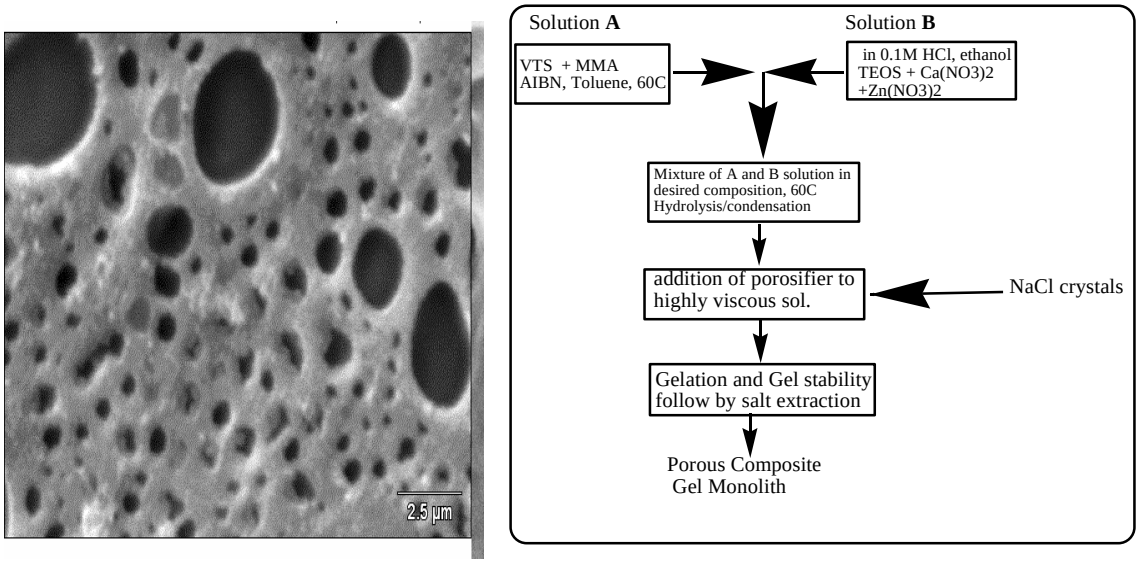
Remi Oki's group

RESEARCH INTERESTS

Our research focuses on the fundamental science and technology questions on creation and behavior of materials at the nanometer scale. Our approach includes the development of methods of synthesis for functional nanomaterials and nano-composites. Target functions range from materials for bone tissues engineering nano-composites for catalysts system for green chemistry and bio-mass transformation.

1.Functional Materials for Bone Tissue Engineering

Bioactive glasses, are able to bond to both bone and soft tissue and can stimulate bone growth. However, their poor mechanical properties has limited their application to the reconstruction of non-stress bearing bone. Mechanical properties of bioglass can be significantly improved when organic polymers are chemically integrated to the inorganic polymer.
Our interest entails the design and synthesis of 3-D macroporous hybrid organic-inorganic materials that will exhibit excellent bone bonding ability, tunable mechanical properties and extended networks of interconnecting macropores and mesopores that will allow for tissue ingrowth.



SEM. Picture of Macroporous Composite.(r), Synthetic Scheme(l)

In addition, we are interested in hybrid composites derived from covalently functionalized carbon nanotubes (F-CNTs) with bioglass as novel material for tissue engineering. CNTs have been extensively investigated because of their unique one-dimensional structure with adjustable electrical conductivity and robust mechanical properties. The tensile strength and modulus of SWNT are estimated to be in the range of 37-100 GPa and 640GPa to 1-2TPa respectively although they are $1/6^{th}$ as dense as steel. (79). Thus F-CNTs-Bioglass hybrids have the potential to be light-weight biomaterials for tissue regeneration. The TEM Micrograpgh showing

dispersion of aminopropyl phosphonic acid functionalized CNT in SiO2, (0.1% wt)

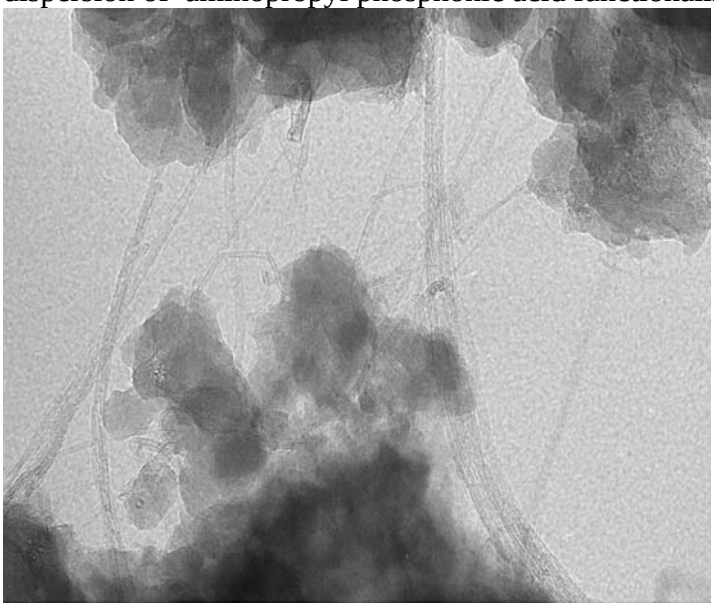
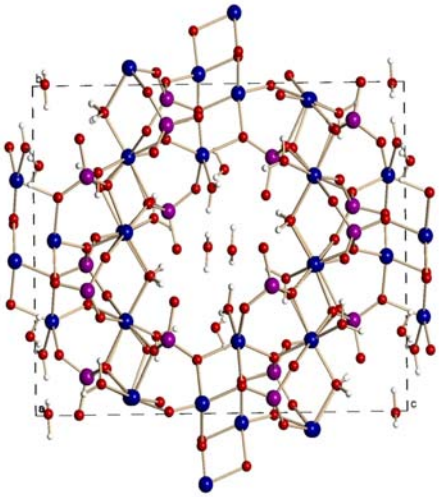


Figure 2. Aminopropylphosphoric acid-CNt in TEOS

2. Novel heterogenous catalyst system based on open framework metal phosphate/and metal oxides

The widespread research on microporous transition metal phosphates, with open-framework structures is due in part to their potential applications as heterogeneous catalysts, sorbent materials, and ion exchangers . Among the vast family of open-framework transition metal phosphates, the cobalt phosphates constitute an important class of compounds. Cobalt can easily exhibit tetrahedral, in addition to five and six fold coordination leading to a large variety of structure types. Our research focuses on the use of different templating agent to direct the structure and channel sizes in open framework cobalt phosphates and substituted derivatives with novel structural features resembling those of known *zeolites.* Among interesting materials synthesized in our laboratory includes a cobalt phosphate with 20 member ring channel Fig.1



Fig,1 cobalt phosphate system exhibiting 4, 5 and 6 coordination
And a cobalt-zinc phosphate with 16 MR channel (figure 2)

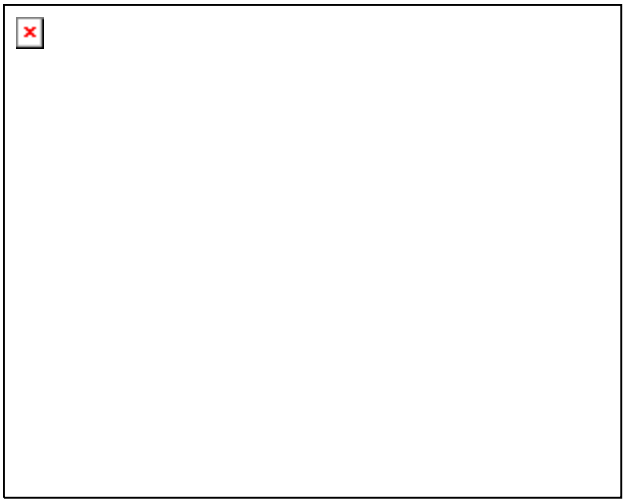
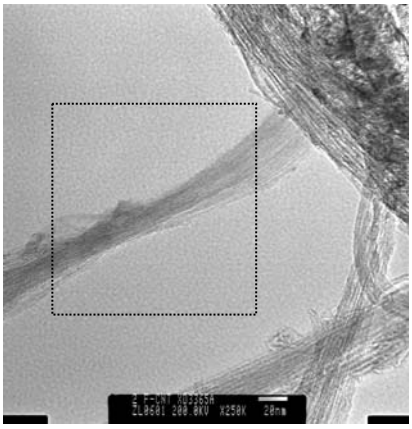


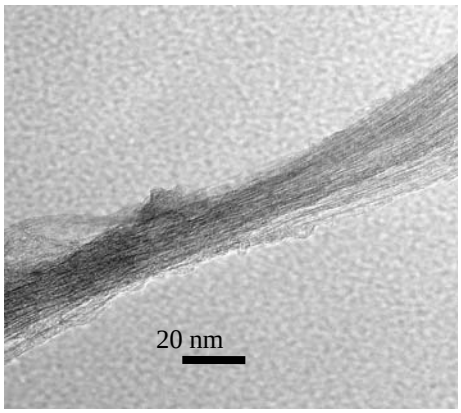
Fig. 2. Co-Zn Phosphate templated by ethylene diamine

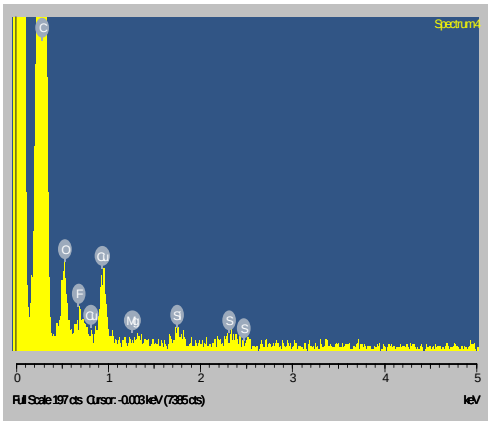
3. Carbon nanotubes and nanocomposites as functional materials in engineering

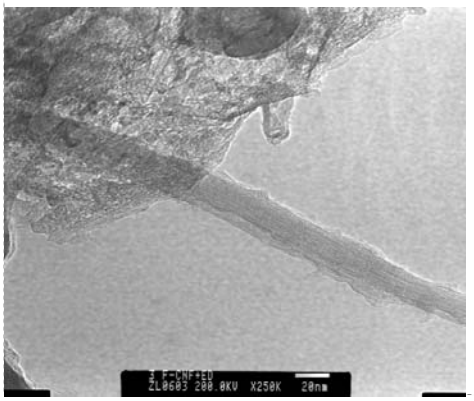
Both single and multi-walled carbon nanotubes possess high tensile strengths, and are ultra-light weight with excellent thermal and chemical stability. Many applications for carbon nanotubes have been proposed in the field of biomedical devices, and materials engineering that include bio-sensors, drug and vaccine delivery, light weight materials. Indeed, carbon nanotubes can be used as nanofillers in existing polymeric materials to both drastically improve mechanical properties and create highly anisotropic nano composites. Incorporation of superstrong lightweight carbon nanotube structures into inorganic matrix (bioglass) offers a novel approach to the design of high performance composite materials with superior mechanical properties**.** However, the atomically smooth graphene surface of nanotubes can provide only limited load transfer from the matrix to nanotubes across the nanotube/polymer interface because of weak Van der Waals interfacial bonding. This causes an easy pull-out of nanotubes from the matrix, rather than fracture, thus limiting their role as a reinforcement. This problem can be overcome by covalent functionalization of carbon nano-tubes. Such functionalization assist effectively in unroping the nanotube bundles and improving the solubility, dispersion, processing and compatibility of carbon nanotubes when blended with the particular matrix. When functional groups are tailored to the polymer structure, they can provide multiple sites for bonding of nanotubes to the polymer matrix so that the load can be efficiently transferred from matrix to the nanotubes.

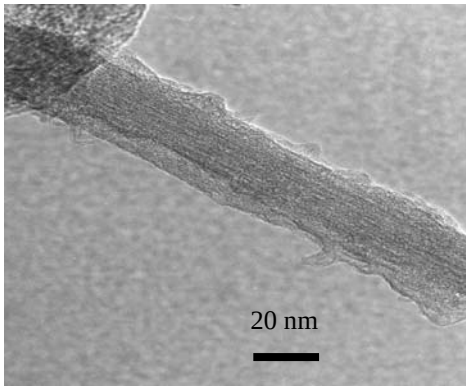
Fluoro-CNTs Top, Ethylenediamine CNTs (bottom)

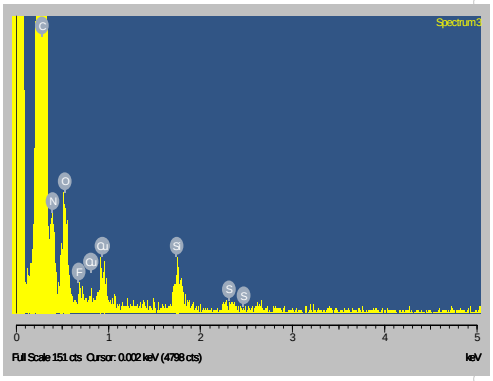












Recent Publications (Student authors in bold)

1. Aderemi Oki, Matthias Zeller, **Yaneth Coranza, Jose Luevano** and Allen D. Hunter, "Hydrothermal synthesis and structure of an open framework $Co_{0.7}Zn_{1.3}$ $(PO_4)_2$ $(NH_3\text{-}CH_2CH_2NH_3)$ and $Co_{6.2}(OH)_4(PO_4)_4Zn_{1.80}$ a new Adamite type phase " Inorg. Chim. Acta, **2007**, in press

2. Aderemi Oki,* Matthias Zeller, **Aurelia Reynolds**, **X. Qiu** and Allen D. Hunter

Synthesis and crystal structure of a neutral open framework cobalt(II) phosphate $Co_6(PO_4)_4\ 7H_2O$ with a channel structure. *J. Coordination Chemistry***, 2007** in press.

3. A. R. Oki , Q. Xu , B. Shpeizer , **X. Qiu,** S. Kirumakki, Shane Tichy, A. Clearfield " Synthesis, Characterization and Activity in Cyclohexene Epoxidation of Mesoporous TiO_2–SiO_2 Mixed Oxides**"** *Catalysis. Communications***. 8 (2007)** 950-956

4. A. S. Amarasekara, A. R. Oki, **I. McNeal, U. Uzoezie** " One-pot synthesis of cobalt-salen catalyst immobilized in silica by sol-gel process and applications in selective oxidations of alkanes and alkenes" *Catalysis. Communications***. 8 (2007)** 1132-1136

5. **Windlyne Delouis[a], Marcos Sanchez,** Boris Shpeizer, Abraham Clearfield and Aderemi Oki " Control of micropore size in supermicroporous titania-chromia-system TiO2-Cr2O3 " *Inorg.Chem.Commun.* **2006,** 9, 1136-1140

6. A.R. Oki,[*] **X Qiu, O. Alawode, and B. Foley** Synthesis of Organic-Inorganic hybrid composite and its thermal conversion to Porous Bioactive Glass monolith. *Materials. Letters* 60 **(2006**) 2751-2755

7. A.R. Oki, **B. Parveen**. **S Hossain** and S. Adeniji and H. Donahue Preparation and in vitro studies on bone cells of sol gel derived bioglass incorporating zinc. J. Biomed Mater. Res., 69A: 216-221 **2004**

8. A. R. Oki, R. Cuero Invention Disclosure: TAMUS